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CURRENT AFFAIRS	THE DANGERS OF SCIENCE AND TECHNOLOGY

Possible Essay Questions

1. To what extent is technological innovation desirable? (MI 2023 Prelims)
2. Are the latest scientific findings or technological inventions a cause for concern? (HCI 2023 Prelims)
3. 'Those who control technology control the world today.' How far do you agree? (NJC 2023 Prelims)
4. 'The pursuit of medical science has gone too far.' Do you agree? (YIJC 2023 Prelims)
5. Consider the argument that scientific research should not be limited by ethical considerations. (TMJC 2023 Prelims)

Introduction - Science and Technology as a Human Endeavour

Science is the study of the natural, empirical world through systematic methods like experimentation. While "science" refers to the theory that underpins our theoretical knowledge, "technology" refers to the tools created based on that theoretical knowledge, typically with the goal of meeting human needs. However, the notion that science and technology should enhance human welfare has not always been present. The 1948 Universal Declaration of Human Rights (UDHR) cements science as a human right. Article 27 of the UDHR reads "Everyone has the right to freely participate in the cultural life of the community, to enjoy the arts and share in scientific advancements and its benefits." While a noble goal, there have been notable instances, past and present, where science has gone against this expectation.

1. The scientific method itself lacks moral checks and balances, warranting the intervention of authorities to ensure the best possible outcomes for research.

- The advancement of scientific knowledge can merely be understood as expanding what we know about the world. This definition does not specify the need to arrive at that knowledge in a righteous or moral manner.
- Indeed, historical cases of human experimentation, and the public outcry they received, jolted regulators to consider imposing codes on how scientific research is conducted.
- Notable cases include Nazi human experimentation, that was largely carried out in concentration camps during WW2, and the Tuskegee syphilis experiment.
- Nazi human experimentation was conducted on prisoners of Nazi-run concentration camps. The studies conducted ranged in their purpose, from the "medical" to the military. Some prisoners were given hypothermia, for the findings to be used on German troops fighting on the cold Eastern Front where they fought Soviet troops. Other prisoners were subject to depressurisation experiments to mimic the conditions of extremely high air altitudes. The findings were meant to be useful for German pilots who had to eject themselves out of their aircraft at high altitudes. These experiments rarely took the welfare of prisoners into account, as many passed during the

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course of these experiments. Other prisoners had been subject to bone, muscle, and nerve transplants without anaesthesia.

The Vacanti mouse – this lab rat has an "ear" on its back, which is actually a cartilage structure made of cow cartilage cells implanted on the mouse.

- The Tuskegee experiment began in 1932, and aimed to track the full progression of syphilis, a venereal disease. 600 African American men were eventually enrolled in the study, with the promise of receiving free healthcare.
- To situate the study against relevant historical details, the United States only began enshrining civil rights for African Americans throughout the 1960s. This suggests a great power and knowledge disparity between the experiment's participants and the researchers. Meanwhile, syphilis, the disease the subjects were being studied for, did not have a cure when the experiment began. By 1947 penicillin came to be a recommended medication for this condition. However, the United States Public Health Service convinced local doctors to not treat the subjects of the Tuskegee experiment.
- Essentially, the researchers prioritised gaining knowledge about syphilis and its effects on the human body, over the health of the participants, who were not fully aware of the experiment's conditions. The story was leaked to the press in 1972, and by this point around 128 participants passed away from their untreated syphilis. Public outrage forced the study to shut down.
- As a result of these cases, the Nuremberg Code and the Belmont Report were created, respectively. The Nuremberg Code is a 10-point statement that establishes guidelines for acceptable experimentation on human subjects. The code was published in 1947. Included among the 10 points are (1) "The voluntary consent of the human subject", (2) "The experiment should be such as to yield fruitful results for the good of society", (4) "The experiment should be so conducted as to avoid all unnecessary physical and mental suffering and injury."
- Meanwhile, the Belmont Report was published in 1979 by the National Commission for the Protection of Human Subjects of Biomedical and Behavioural Research. The report contains three basic ethical principles to guide research, including respect for persons, beneficence, and justice. Much like the Nuremberg code, when it comes to applying these principles in research, the Belmont Report emphasises consent and the careful assessment of risks and benefits.

➢ What is evident in these cases is that science, in practice, is rarely insulated from the ongoings of the society it is based in. The practice of science is affected by power and politics. After all, scientists are people who can be influenced by agendas within and without. These motivations can quickly turn an intellectual endeavour into a baneful one.

➢ Thus, it is important for such clear codes of ethics to be established to avoid such deplorable practices, or at least, ensure the relevant researchers face the appropriate consequences in the aftermath. The outcry such cruel forms of human experimentation received, even when such codes were not present, demonstrates that our intuition does find something inherently reprehensible about such forms of science.

- There are of course, also regulations of this nature that extend to animal testing. Animal testing is an ongoing practice in many parts of the scientific world precisely because of the importance

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of protecting human welfare. According to Stanford's Medicine faculty, animals are biologically remarkably similar to humans and have shorter life spans, which allows scientists to see the life-long effects of the research. For example, mice share 98% of DNA with humans and in lab conditions live up to 26 to 30 months on average.

- In principle, it is immoral to subject animals to harm. This is where animal testing becomes contentious. Some might acknowledge this, but then defend the practice on the grounds that the results of animal testing are critical to creating advancements that bring much greater gains to humanity. Others would point out that an alternative to experimenting on live animals is to experiment on animal tissues, and this is an option that would minimise potential suffering.
- Still, even if there are significant benefits for humanity, that does not justify morbid experimentation practices on animals. Most countries have regulations in place for animal testing to minimise potential cruelty. In Singapore, for example, there are the Animals and Birds (care and use of animals for scientific purposes) rules under the Animals and Birds Act. These rules guide researchers to follow the '3Rs', to replace animals with alternative methods where possible, to reduce the number of animals used, and the refinement of techniques to minimise harms to animals. Practices like ensuring researchers are adequately trained and have licenses to experiment on animals are in place to ensure transparency.
- Lastly, such forms of regulation are not just applied to cases of outright cruelty, but in various other instances where ulterior motives may compromise the quality of the findings and generate other adverse consequences during the research process.

2. As science develops, successive breakthroughs become costlier to fund, making the field more commercialised. The resultant paywall denies all of humanity the ability to universally benefit from the gains of scientific knowledge.

- Since science matters so much to humanity's collective welfare, it is understandable for one to assume that it should be controlled, to the extent that regulations ensure it can meet this expectation.
- However, it is unrealistic for governments to be the only external party involved in the scientific field. As time passes, science will get more advanced, and this requires greater funding for each breakthrough.
- In an article published by the Atlantic, writers Michael Collinson and Michael Nielsen find that scientific funding has grown from 10 billion USD in the 1960s to about 40 billion USD in 2018. Compared to past generations of scientists, this has been one of the steepest rises in funding. Collinson and Nielsen point out that at the same time, the number of scientific papers being published has grown at a similar rate too, suggesting that such prominent levels of spending are making a significant contribution to the field.
- However, the output of research papers is not the only indicator on what makes the field successful. If science's benefit is found in how it benefits humanity, the mass of research currently published might not have the most significant impact on the welfare of the average individual.
  - In the same article, Collinson and Nielsen refer to the works of economists Tyler Cohen and Robert Gordon. They point out that many **general use** technologies, like transportation and energy infrastructure, reached an approximation of their modern form by the 1970s. Since then,

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progress has been relatively incremental. Under this view, there is an argument that can be made that science is costing humanity more than it is worth.

- That is not to say that there are no modern technologies at all that can revolutionise the way we live. For instance, Artificial Intelligence is arguably on the cusp of doing so, what with the invention of self-driving cars. If such inventions do go mainstream, then it can be said that prior periods of slow progress were ultimately worth it. Furthermore, it seems unrealistic to argue that scientific funding should be halted just because progress is slow, as the alternative would no progress whatsoever in our understanding of the material world.

- Even if one agrees that science deserves great funding, one can still take issue with where the scientific field gets its funding from. Taking money from private sources means that corporate interests may divert scientific agendas away from serving humanity, towards more profit-maximising objectives.
- One can look at how "Big Pharma" has decided to use its funding to see the ills of this. In 2014, Pharmaceutical giant AstraZeneca decided to pause research on malaria and tuberculosis. These are diseases that tend to affect developing countries with poor sanitation. With the pause on such research, the company redirected the funds to developing drugs for asthma, diabetes, and high blood pressure. These diseases tend to be more common in high income, developed countries.
- This suggests that science that is privately funded is more likely to place funding on profitable findings. For impoverished individuals afflicted with malaria and tuberculosis to access drugs developed by AstraZeneca, the company would have the sell them at an affordable price. This is less of a concern when the company focusses its efforts on selling products to high paying customers. From this we can see how science detracts from its moral imperative to uplift all of humanity.

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3. The science and its advancements are not absolutely good, as novel technologies can bring novel problems with them.

- Innovation requires scientists and researchers to venture into unknown territory, and to create novel solutions to yet unaddressed problem. The issue is that science, when applied to novel technologies often bring with them unpredictable effects.
- The issue with innovative technologies is that their long-term consequences will remain unknown until they have been used for some time. At the point where these adverse consequences do surface, the scientific community may lack the answers for an equally novel problem.
- Aside from Artificial Intelligence and gene editing, another example of a new technology with questionable implications is Neuralink. Neuralink is the eponymous brain chip created by an Elon Musk-founded company. As its description suggests, Neuralink is meant to be implanted into a user's brain. After which, it would register brain activity and use Bluetooth connection to apply it to a device. This would allow people to control devices, like their phones, only with their thoughts.
- Musk believes this technology to be a major advancement in the medical field. Aside from its novelty, a Neuralink chip that works as intended would be a major advancement in accessibility. It would allow physically impaired individuals to continue using devices without limitations they currently experience.

- However, with the involvement of surgical procedures and the question of privacy concerns, Neuralink has come under scrutiny for ethical concerns. Regulations in the scientific sector are put in place not just to prevent outright cruelty, but also to ensure the best practices are put in place. The justification here is that ensuring accountability and transparency will minimise the chances of adverse side effects being produced.
- To be fair to the scientific community, other researchers have criticised the chip for failing to abide by the best practices established by the scientific community.
- Neuralink did get approval from the US Food and Drug Administration (FDA) to begin testing on humans. In January 2024, the first human received a Neuralink chip implant. As usual, this was announced by Musk via X. However, there are other recommended, but optional, practices that Neuralink did not adopt. For example, in the United States clinical trials can be made publicly available on the website ClinicalTrials.gov. The intention here is to encourage transparency as companies conduct research. Neuroethicist Laura Cabrera at Pennsylvania State University points out that while Neuralink is not obliged to do this, this situation points towards weaknesses in current regulations.

➢ This case also demonstrates that it is difficult to frame the scientific community in simplistic terms. While some stakeholders use lax regulations to get by with questionable practices, others are very willing to double down on the importance of ethical practices. This goes back to our prior understanding of science as a field that can be morally neutral. There are good faith actors too who want to minimise possible harms in the sector.

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- To return to the possible adverse consequences that might stem from Neuralink, observers fear that the chip might make possible constant surveillance. The fact that all of an individual's neural activity is being processed by the chip then brings up the question of ownership. If it is currently questionable if a person's data online is owned by them or the platform they are using, this technology threatens to expand the scope of this debate in a worrying way.
- The misuse of certain forms of technology can also generate other problems. Antibiotics are medications used to treat bacterial infections. However, the misuse and overuse of antibiotics in humans, animals and plants can also create drug-resistant pathogens.
- In 2019, anti-microbial resistance (AMR) directly took the lives of 1.27 million people and contributed to the deaths of 4.95 million people. According to Sally Davies, the former chief medical officer of England, this could be the next major health threat that humanity faces. She warns that it could be much more severe than virus-related pandemics like COVID-19 because herd immunity is not a viable strategy for bacterial infections that have developed immunity to antibiotics.
  - The fallout from such a crisis is likely to be disproportionately felt by low-income nations, which also happened during COVID-19. Individuals infected by uncurable bacterial infections must be isolated from others, and this requires substantial healthcare infrastructure. According to a 2020 report published by the United Nations Development Programme, the 20 most vulnerable countries in the world will run out of ICU beds if even 0.04% of their population is infected. "Vulnerable" here takes into the account the income level of the country and the capacity of its healthcare system.

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